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PROGRESS REPORT

ON

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"DESIGN CRITERIA FOR RADIATION RESISTANT

FLIGHT CONTROL SYSTEMS FOR AEROSPACE VEHICLES"

Period Covered: 1 June — 30 June 1962

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1. Technical Areas

The description of technical effort will be divided into the three areas of major effort for this period.

A. Determination of Radiation Penetration Through the Satellite Walls.

Progress has been made in the penetration calculations. The bremsstrahlung program has been corrected to give satisfactory results, the Freden and White Van Allen proton spectrum has been run on the "Proton Shielding Program", and numerous calculations as described below have been made determining the dose rate versus time for the solar flare of 28 September 1961.

Regarding the bremsstrahlung program, two minor programming corrections and the inclusion of photon attenuation along with photon production have resulted in satisfactory results. Now that the program is checked out, it only remains to run the program with smaller decrements to increase accuracy and include shielding by adjacent components to obtain the dose due to Van Allen electrons.

The results of the Freden and White Van Allen proton spectrum when input into the "Proton Shielding Program" give the dose received from the forward 2π steradians. While this is anticipated to produce the principal component of the dose received from Van Allen proton, calculations are being made to include the dose from the other 2π steradians, taking into account the shielding typically provided by the other components in the "black-box".

Solar flare penetration has not been completely resolved as yet. Data from the 28 September 1961 flare has been processed by the "Proton Shielding Program" to provide the dose rate vs time for various amounts of shielding. This utilized the differential spectrum, $\varphi_{UE}(E)$, for several times and therefore results in a dose rate which is a function of time.

This approach while providing a means of obtaining the time integrated dose is not as desirable as having the basic time integrated φ_{UE}. The time integrated φ_{UE} will be obtained by fitting $\varphi_{UE}(E_i,t) = f(t)_i$ with a polynomial least square fit for each energy. Then integrating each $f(t)_i$ with respect to time in order to obtain the value of $\varphi_{UE}(E_i)$ (time integrated differential flux) for each energy. This then provides the time integrated differential flux-energy spectrum which will be used to obtain dose and will be checked by the previously obtained time integrated dose.

While the first effort, defining the spectra impinging on components, is essentially completed for each environment, it must be translated into the dose received on the specific missions under consideration. This effort will be completed and incorporated into a report to accompany the sixth monthly progress report.

B. Determination of Radiation Damage Criteria

To simplify the correlation of present data on the damage to irradiated organics with space radiation damage, the concept of equal energy absorption resulting in equal damage to the organic material (regardless of the type of irradiating particle) has been investigated. The investigation to date indicates that the equal energy - equal damage premise holds for most organics excluding the aromatic hydrocarbons and holds for all organic materials within a factor of two or three. The equal energy absorption - equal damage premise, with certain restrictions, will be used in correlating the space radiation damage to organic materials in the proposed flight control system.

Preliminary calculations have been made of the primary knock-on spectrum due to protons, neutrons, and electrons. These calculations

will be employed to correlate the radiation damage where displacements are the effective damaging mechanism.

C. Determination of Radiation Effects on Flight Control System

Nuclear radiation damage thresholds for the typical flight control components and materials listed in report NSL-62-90 have been determined with the exception of semiconductor devices. The damage thresholds for semiconductors will be determined separately as a part of the correlation studies.

The nuclear radiation damage threshold listings contain many entries not appearing in NSL-62-90. The additional data includes both materials more susceptible and materials more resistant to radiation than those chosen as typical.

The object of this approach is to provide a wide range of data on materials and components which may "typically" be found in flight control systems but were not included in the selected "typical" system described in NSL-62-90.